Development and Testing of the Clinical Research Appraisal Inventory-Short Form

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Background and Purpose: The National Academy of Sciences stressed the need for a doctorally prepared workforce and earlier entry into doctoral study in nursing and the behavioral, social, and basic sciences. Social Cognitive Career Theory (SCCT) suggests that self-efficacy for career related skills informs career choices. Thus, increasing clinical research self-efficacy early in students' studies could increase their choice of a research career. To test interventions, a psychometrically sound measure of clinical research self-efficacy is needed. Methods: We examined the psychometrics of the Clinical Research Appraisal Inventory-Short Form (CRAI-SF) in undergraduate and first-year graduate students (N = 268). This scale is a modification of the Clinical Research Appraisal Inventory, which measures physician–scientists' clinical research self-efficacy. Results: Content validity was supported by external review. Factor analysis revealed six factors explaining 75% of scale variance. Internal consistency of subscales and total scale ranged from .84 to .98. Differences in scores by gender (p = .016) and discipline of study (p = .000) supported construct validity. Conclusions: The CRAI-SF is a useful measure of undergraduate and first-year graduate students' perceived clinical research self-efficacy.

Keywords: clinical research; Social Cognitive Career Theory; self-efficacy; psychometrics

Nursing research builds the scientific foundation for practice and the conduct of research is the role of doctorally prepared nurses. Although 13.2% of nurses have a graduate degree, less than 1.0% have a doctorate (Institute of Medicine, 2011), and nurses begin research careers later in life (National Institute of Nursing Research, 2010). With the increased emphasis on evidence-based practice, it is critical that steps be taken to increase the number of students who select nursing research careers. The shortage of a doctorally prepared workforce is not exclusive to the discipline of nursing and, in fact, extends to other the biomedical, behavioral, social, and clinical sciences (National Academy of Sciences [NAS], 2011). Social Cognitive Career Theory (SCCT) and some empirical evidence supporting it suggest that college students with higher self-efficacy for research are more likely to select a career in research. Thus, interventions to increase research self-efficacy in this population may increase interest in research, which in turn may increase the number of research scientists. To test the effects of such interventions, a psychometrically sound measure of clinical research self-efficacy in undergraduate and

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first-year college students is needed. Most of existing measures examine self-efficacy for general research knowledge and skills but do not assess self-efficacy for the clinical research skills relevant to disciplines that conduct research with human subjects. In addition, these measures have been developed to measure research self-efficacy primarily in graduate and post-doctoral students rather than students earlier in their studies. The one published clinical research self-efficacy measure, the Clinical Research Appraisal Inventory (CRAI), was developed to measure this construct in physician-scientists (Mullikin, Bakken, & Betz, 2007). The purpose of this study was to assess the psychometric properties of the Clinical Research Appraisal Inventory-Short Form (CRAI-SF), a measure of self-efficacy for clinical research in undergraduate and first-year graduate college students. This measure is a modification of the CRAI (Mullikin et al., 2007).

BACKGROUND

In a recent report addressing the national needs for biomedical, behavioral, and clinical research personnel, the NAS (2011) addressed the need for a doctorally prepared workforce in these fields. Increasing the number and diversity of students entering research careers is a goal of academicians as well as the National Institutes of Health (Allen, Eby, & Lentz, 2006; Desai et al., 2008). The NAS report specifically addresses the current shortage and projections for a continued shortage of nurse researchers and scientists, and recommends several steps for addressing the shortage of nurse investigators. These steps include earlier entry and more rapid progression to doctoral and post-doctoral study, increasing the number of those entering doctoral studies and an emphasis on research-intensive training environments (NAS, 2011). To facilitate these efforts, one recommendation is to move nursing undergraduates directly into doctoral education. For this to succeed, it will be necessary to increase undergraduates' interest in research careers by engaging them in mentoring relationships and faculty research, thereby increasing their clinical research self-efficacy.

There is a paucity of current scholarly evidence examining research self-efficacy and its measurement, and career choices in undergraduate and first year graduate students. Early studies support the premise that efficacy beliefs influence career choices and educational pursuits (Betz & Hackett, 1986; Hackett, 1985; Lent, Brown, & Hackett, 1994). Several investigators later demonstrated positive changes in research skills and research career decisions in undergraduate and graduate students following their exposure to a research experience intervention (Lopatto, 2004; Morrison-Beedy, Aronowitz, Dyne, & Mkandawire, 2001; Moss & Nesbitt, 2003; Randall, Wilbur, & Burkholder, 2004). In one study, 1,135 science undergraduate students who had completed a summer undergraduate research experience completed an online survey to assess their perceptions of outcomes (Lopatto, 2004). The highest rated item was their "understanding of the research process," which received an overall mean rating of 4.13 on a scale of 1 (*no gain*) to 5 (*very large gain*). In addition, 91% reported a sustained or increased interest in postgraduate education and 27% reported a positive attitude change toward postgraduate education and a science career.

Gelso, Mallinckrodt, and Judge (1996) examined how the research training environment (RTE) influences doctoral students' interest in research. Faculty modeling, a critical ingredient of the RTE, facilitates students' positive attitudes toward research and their research productivity. They observed that research self-efficacy mediated the relationship between the RTE and research productivity.

Research training, experiential learning, and mentoring prepare students for research careers and are thought to increase students' self-efficacy for research (Brownson, Samet, & Thacker, 2002; Desai et al., 2008; Fuller, 2000; Lopatto, 2004; Morrison-Beedy et al., 2001; Moss & Nesbitt, 2003; Randall et al., 2004; Reynolds, 2008). Self-efficacy beliefs are stronger predictors of behavior than skills or knowledge (Multon, Brown, & Lent, 1991; Phillips & Russell, 1994). Thus, strategies that increase self-efficacy for research logically would increase motivation to select a career in research.

Measures of research self-efficacy have been developed in psychology, social work, and education. Although psychometrically sound, they measure self-efficacy for general research knowledge and skills, and most were developed for students at later stages in their education. None of the scales reviewed measure self-efficacy for knowledge and skills relevant to clinical research. Thus, they are not appropriate for the measurement of clinical research skills in undergraduate or first-year graduate students.

The Self-Efficacy in Research Measure (SERM) was developed to assess the research self-efficacy of graduate students in counseling psychology (N = 219; Phillips & Russell, 1994). The SERM is a 33-item scale with four subscales (practical research skills, quantitative and computer skills, research design skills, and writing skills). Good internal consistency (total scale alpha = .96, subscale alphas from .83 to .94) and significant correlations between research self-efficacy and research productivity (r = .45) and between self-efficacy and the research training environment (r = .39) were observed (Phillips & Russell, 1994).

The Research Self-efficacy Scale (RSES) measures doctoral students' perceived ability to perform research-related behaviors. The RSES began as a 53-item scale (Greeley et al., 1989) and was subsequently reduced to 51 items (Bieschke, Bishop, & Garcia, 1996). Items are rated on a scale ranging from 0 (*no confidence*) to 100 (*complete confidence*). Coefficient alpha was .96 for the 51-item scale in a sample of doctoral students (N = 177) from various disciplines (humanities, social sciences, and biological sciences; Bieschke et al., 1996).

The RSE was developed to assess the outcome of research education in undergraduate and graduate social work students (N = 71; Holden, Barker, Meenaghan, & Rosenberg, 1999). Research self-efficacy was conceptualized as a component of social work self-efficacy. The RSE is a nine-item scale, with responses ranging from 0 (*cannot do at all*) to 100 (*certainly can do*). A total research self-efficacy score is computed by dividing the sum of individual item scores by the number of items in the scale. Cronbach's alpha reliability for the scale in a sample of undergraduate and graduate social work students was .94.

The Research Self-efficacy Scale (RSS) was developed by Büyüköztürk, Atalay, Sozgun, and Kebapçi (2011). This 18-item scale measures students' self-efficacy in carrying out the "fundamental tasks" of research. Each item is scored on a 5-point scale ranging from 1 (*do not agree completely*) to 5 (*agree completely*). In a sample of 310 undergraduate and postgraduate students in education, Cronbach's alpha reliability for the scale was .87.

The Science Self-efficacy Scale (SES) is a 10-item to 13-item measure of the respondent's ability to function as a scientist (Chemers, Zurbriggen, Syed, Goza, & Bearman, 2011). The shorter scale measures science self-efficacy in undergraduate students. The longer scale, targeted to graduate and postdoctoral students, includes more advanced research skills and knowledge. Responses on 5-point scale range from 1 (*not at all confident*) to 5 (*absolutely confident*). Cronbach's alpha reliability was .94 in undergraduates/recent graduates (N = 327) and .95 in graduate students and postdoctoral fellows (N = 338; Chemers et al., 2011).

CONCEPTUAL FRAMEWORK

The CRAI, from which the CRAI-SF was derived, was based on SCCT, and grounded in Bandura's (1986) social cognitive theory. The concept of self-efficacy is central to social cognitive theory, which posits that behavior is based largely on one's confidence in the ability to perform that behavior, rather than knowledge and skills. Self-efficacy is defined as one's beliefs about the capability "to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391). Self-efficacy provides motivation, guides life choices, and helps the individual deal with failures and setbacks (Bandura, 1994). Building on the key constructs of social cognitive theory, SCCT posits that career interests and choices are a function of self-efficacy beliefs, outcome expectations, and personal goals, with self-efficacy the most salient (Lent et al., 1994, 2000, 2002). Thus, based on SCCT, increases in clinical research self-efficacy, as measured by the CRAI-SF, may lead to students' choice of a research doctorate and, ultimately, a research career.

PROCEDURES FOR INSTRUMENT DEVELOPMENT

The CRAI, on which the CRAI-SF is based, was developed to assess clinical research self-efficacy in physicians training for clinical research careers (physician-scientists) to understand the role of self-efficacy in the development of their careers (Bakken, Sheridan, & Carnes, 2003; Mullikin et al., 2007). It measures the individual's perceived abilities to perform tasks and activities needed to conduct clinical research (i.e., clinical research self-efficacy). The psychometrics of the CRAI were supported, however its reliability and validity in undergraduate and graduate students was untested.

The design of the CRAI followed Bandura's guidelines for constructing self-efficacy scales (Mullikin et al., 2007). Bandura (2006) suggests that the definition of the construct and the domain of behaviors of interest are a critical first step in the development of measures of self-efficacy expectations. In the development of the CRAI, clinical research self-efficacy was broadly defined and resulted in the identification of 10 skill sets. These included (a) conceptualizing a study (10 items); (b) designing a study (12 items); (c) collaborating with others (8 items); (d) funding a study (10 items); (e) planning and managing a study (11 items); (f) protecting research subjects (11 items); (g) collecting, recording, and analyzing data (11 items); (h) interpreting data (4 items); (i) reporting a study (12 items); and (j) presenting a study (3 items). Development of the original CRAI is described in detail by Mullikin et al. (2007). The 92-item CRAI formed the basis for this study.

In the study reported here, which is part of a larger study, the CRAI was administered to undergraduate and first-year graduate students in mentored research relationships with faculty. In the larger study, an initial sample ($N = 80$) of undergraduate and first-year graduate students were administered the 92-item CRAI. It was observed that most respondents selected "not applicable" for many of the scale items. Based on the number of unendorsed items (not applicable responses) on specific questions of the CRAI in this population, we concluded that the 92-item CRAI includes dimensions that are not relevant to skills acquired in mentored research and clinical research self-efficacy at the undergraduate and first-year graduate levels. These included (a) funding a study; (b) planning and managing a study; (c) collecting, recording, and analyzing data; and (d) interpreting data. Based on these observations, 46 items in six dimensions of the original CRAI were retained in the short form CRAI (CRAI-SF), and this shortened version of the original scale was tested for use in this population.

DESCRIPTION, ADMINISTRATION, AND SCORING OF THE CRAI-SF

The CRAI-SF is a 46-item instrument with a 10-point Likert-type response format that takes approximately 15 minutes to complete. Response choices range from 1 (*no confidence*) to 10 (*total confidence*). Respondents are instructed: "The following items are tasks related to performing clinical research. Please indicate your confidence in your ability to perform each task by selecting a single number from 1 to 10 that best describes your level of confidence today." Each item consists of a short descriptive phrase of a research-related task. Total scores are obtained by summing numeric responses to each item. The higher the score, the higher the respondent's research self-efficacy. The CRAI-SF has six subscales. The possible range of scores for the total scale is 46 to 460.

METHODS

Sample and Procedures

There were 268 undergraduate and first-year graduate students from the disciplines of natural sciences (50.9%), engineering/mathematics (31.3%), and nursing/health sciences (17.5%) completed the CRAI-SF. Students were participants in a randomized clinical trial of a research-efficacy-enhancing intervention and were enrolled in 12 universities in the United States and Puerto Rico (see Table 1). All study participants had research experience. They were protégés in a mentoring relationship with a research faculty member and were collaborating with their mentor on research projects.

Approval for the study was obtained from the university institutional review board of the investigators (LE, EL) and, when required, from the review boards of universities where the clinical trial was being conducted. Study instruments were completed on a web-based system in a secure, log-on enabled environment. HTTPS, the secure socket layer, was used to encrypt data being sent between browser and server to prevent third party access. User authentication was handled through NTLM to create physical user accounts on the web server for users to log in.

Measures

Sociodemographic Characteristics. An investigator-developed survey was used to collect information regarding gender, race, level in school (undergraduate/graduate), and discipline of study.

Science Self-Efficacy Scale. This scale, a general measure of research self-efficacy, was included to assess the construct validity of the CRAI-SF. The SES measures undergraduate students' confidence in their ability to function as a scientist (Chemers et al., 2011). Ten items consist of short phrases describing specific research-related skills. Respondents are instructed to indicate the "extent to which you are confident you can successfully complete the following tasks." A 5-point Likert scale response format ranges from 1 (*not at all confident*) to 5 (*absolutely confident*). Total scores are obtained by summing numeric responses to each item, higher scores indicate greater research confidence. The possible range of scores for the total scale is 10–50. Cronbach's alpha in previous studies was .94 for an undergraduate sample and .95 for a sample of graduate students (Chemers et al., 2011). Cronbach's alpha for the scale in this study was .82.

Data Analysis

Data were analyzed using the Predictive Analysis Software (PASW®) for Windows Version 19.0 software. Descriptive statistics were used to examine sample characteristics. The CRAI-SF was based on an existing scale, therefore confirmatory principal component analysis with Varimax rotation and Kaiser normalization was conducted to confirm the structure of the 46-item CRAI-SF. One-way between-subjects ANOVAs were conducted to compare the effect of gender, race, and level of study on CRAI-SF scores. A one-way between-subjects ANOVA was also conducted to compare the effect of respondents' discipline of study on Factor 5 (protecting research subjects) of the CRAI-SF, which addressed content specific to clinical research. Correlations between CRAI-SF scores and those of the SES were examined. Internal consistency reliability of the total scale and each subscale was analyzed using Cronbach's alpha coefficient. A value of $>.70$ was considered adequate (Nunnally & Bernstein, 1994).

RESULTS

Most of the sample consisted of female, White, non-Hispanic undergraduate students. Descriptive statistics for the sample are presented in Table 1.

Content Validity

A panel of four experts conducted a review of the 46-item CRAI-SF for content validity. Item content, clarity, and comprehensiveness were assessed (Grant & Davis, 1997). Three of the experts were clinical researchers (an MD, an EdD, and a PhD) who serve as research mentors for undergraduate and graduate students. The fourth was a PhD student who was project manager of a clinical study, and who mentored undergraduate research assistants. The CRAI-SF was reviewed individually by the experts for item-to-item relevance and sufficiency to the six dimensions of clinical research skill, readability, and clarity. A scale content validity index (S-CVI) was calculated. The relevance of each item was rated on a continuum ranging from 1 (*not relevant*) to 4 (*highly relevant*). All items were rated either "*quite relevant*" or "*highly relevant*" by the experts. Averaging was used to calculate the S-CVI, with the criterion set at .90 (Polit & Beck, 2012). There was 100% agreement, thus the S-CVI for the CRAI-SF was excellent, at 1.00. Three additional items were suggested for inclusion in the scale. These were "articulating future steps and research needed," "develop an analysis plan to guide data analysis," and "identify outlier and nonsense data values before analysis."

Construct Validity

Confirmatory factor analysis supported the construct validity of the CRAI-SF. Based on the "rule of thumb" of five cases per observed variable, the sample size was sufficiently large for a factor analysis (Tabachnick & Fidell, 2012). The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was .94, and Bartlett's test of sphericity ($\chi^2 = 6853.0$, $df = 1035$, $p = .000$) was significant, supporting factorability of the matrix (Tabachnick & Fidell, 2012). Analysis resulted in six factors with eigenvalues ≥ 1.0 that accounted for 75% of the variance in the scale. Inspection of the scree plot supported the six-factor solution. All item factor loadings except one, which was .30, were $\geq .40$. Factors were named

TABLE 1. Descriptive Statistics for Study Participants (N = 268)

Characteristic	N	%
Gender		
Female	158	59.0
Male	110	41.0
Ethnicity		
Hispanic or Latino	51	19.0
Race		
White, non-Hispanic	148	55.2
White, Hispanic	33	12.5
Asian	35	13.0
African American or Black	28	10.4
More than one race	17	6.3
Native Hawaiian or Other Pacific Islander	4	1.5
American Indian or Alaskan Native	3	1.1
Educational Level		
Bachelor's	226	84.3
Master's	42	15.7
University Region		
South	145	54.1
Northeast	64	23.9
West	32	11.9
Midwest	12	4.5
Puerto Rico	15	5.6

as follows: Factor 1 - conceptualizing a study and writing a proposal; Factor 2 - designing a study; Factor 3 - reporting a study; Factor 4 - collaborating and organizing a study; Factor 5 - protecting research subjects; and Factor 6 - presenting a study. The six factors, factor loadings, item-to-subscale correlations, and variance explained of the CRAI-SF are presented in Table 2.

Descriptive statistics for the total and subscale scores of the CRAI-SF are presented in Table 3.

There was a significant difference by gender (F = 5.84, p = .016). Males had higher CRAI-SF scores (M = 329; SD = 58.5; range 175–454) than females (M = 323; SD = 83.9; range 55–460). There were no differences in CRAI-SF scores by participant race or level of study (undergraduate or graduate).

Significant differences in scores on Factor 5 (protecting human subjects) were observed by discipline, $F(2, 265)$ = 8.90, p = .000. Post hoc comparisons using the Fisher LSD test revealed that mean CRAI-SF scores of those in nursing/health sciences (M = 22.17, SD = 4.82) were significantly higher than those in both natural sciences (M = 19.06, SD = 10.54) and engineering/mathematics (M = 18.94, SD = 4.78).

TABLE 2. Abbreviated Items, Dimensions, Factor Loadings, and Internal Consistency for CRAI-SF

Item/Factor	Variance Explained	Factor Loading	Item-to-Subscale Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Factor 1: Conceptualizing a study and writing a proposal	19.5%				.93
Q1 Select topic		.68	.66	.92	
Q2 Refine problem		.67	.77	.91	
Q3 Develop rationale		.75	.81	.91	
Q4 Write proposal		.50	.72	.92	
Q5 Articulate purpose		.66	.78	.91	
Q6 Identify gaps		.66	.81	.91	
Q7 Theoretical rationale		.65	.81	.91	
Factor 2: Designing a study	15.0%				.96
Q8 Compare study designs		.54	.72	.96	
Q9 Threats to validity		.52	.78	.96	
Q10 Choose design		.63	.83	.95	
Q11 Justify design		.50	.80	.96	
Q12 Design quantitative study		.67	.78	.96	
Q13 Determine study population		.55	.77	.96	
Q14 Determine sample size		.69	.77	.96	
Q15 Design data collection		.70	.85	.96	
Q16 Determine measurement methods		.77	.78	.96	
Q17 Select instruments		.80	.82	.96	
Q18 Design data analysis		.67	.83	.96	
Q19 Evaluate psychometrics		.51	.78	.96	
Q20 Analyze data		.49	.79	.96	
Q21 Perform statistical tests		.45	.62	.96	

TABLE 2. Abbreviated Items, Dimensions, Factor Loadings, and Internal Consistency for CRAI-SF ***(Continued)***

Item/Factor	Variance Explained	Factor Loading	Item-to-Subscale Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Factor 3: Reporting a study	11.5%				.94
Q22 Generate computer graphics and charts		.44	.63	.95	
Q23 Explain outcomes		.55	.81	.94	
Q24 Express theoretical and methodological cautions		.60	.83	.94	
Q25 Identify study limitations		.55	.78	.94	
Q38 Integrate findings into the literature		.53	.82	.94	
Q39 Select journal for submission		.51	.66	.95	
Q40 Write Literature Review		.60	.72	.94	
Q41 Write Methods section		.76	.80	.94	
Q42 Write Results section		.75	.85	.94	
Q43 Write Discussion section		.72	.86	.94	
Factor 4: Collaborating and organizing a study	11.2%				.92s
Q26 Consult with senior researchers		.79	.71	.91	
Q27 Identify collaborators		.77	.77	.90	
Q28 Initiate collaborations		.68	.72	.91	
Q29 Generate collaborative research ideas		.74	.76	.90	
Q30 Work in a group		.52	.67	.91	
Q31 Adhere to a timeline		.51	.68	.91	
Q32 Maintain system for ideas and references		.53	.72	.91	

(Continued)

TABLE 2. Abbreviated Items, Dimensions, Factor Loadings, and Internal Consistency for CRAI-SF *(Continued)*

Item/Factor	Variance Explained	Factor Loading	Item-to-Subscale Correlation	Cronbach's Alpha if Item Deleted	Cronbach's Alpha
Q33 Maintain research log		.57	.63	.91	
Q34 Construct plan for file management		.30	.68	.91	
Factor 5: Protecting research subjects	9.4%				.91
Q35 Describe appropriate recruitment and retention methods		.79	.79	.89	
Q36 Obtain informed consent		.88	.85	.84	
Q37 Write consent form		.83	.82	.87	
Factor 6: Presenting a study	8.6%				.83
Q44 Design visual presentation		.58	.59	.86	
Q45 Orally present results		.70	.77	.69	
Q46 Defend results to critical audience		.70	.75	.71	

Convergent Validity

A subset of participants ($n = 25$) completed both the CRAI-SF and the 10-item SES (Chemers et al., 2011). Significant correlations ($r = .46$, $p = .02$) were observed. There were significant, positive correlations (0.38–0.74) between all six subscales of the CRAI-SF.

TABLE 3. Descriptive Statistics of the Total and Subscale Scores of the CRAI-SF

Subscale	Possible Range	Actual Range	Mean (*SD*)
Conceptualizing a study and writing a proposal	7–70	7–70	52.4 (10.8)
Designing a study	14–140	14–140	96.3 (21.8)
Reporting a study	10–100	12–100	70.8 (16.6)
Collaborating and organizing a study	9–90	14–90	69.6 (13.3)
Protecting research subjects	3–30	3–30	19.2 (5.6)
Presenting a study	3–30	3–30	21.7 (5.7)
Total CRAI-SF	46–460	5–460	339.9 (63.3)

Reliability

Cronbach's alpha reliability coefficient for the total scale was .98, and for the subscales ranged from .84 to .96 (see Table 2). For the "conceptualizing a study and writing a proposal subscale," inter-item correlations were medium to high (r = .41–.79) as were the item-total correlations (r = .73–.86). For the "designing a study" subscale, inter-item correlations were medium to high (r = .48–.83) as were the item-total correlations (r = .77 .83). For the "reporting a study" subscale, inter-item correlations were medium to high (r = .36 .86); item-total correlations were high (r = .73–.91). For the "collaborating and organizing a study" subscale, inter-item correlations were medium to high (r = .43 .81) and the item-total correlations were high (r = .69–.87). For the "protecting research subjects" subscale, inter-item correlations were high (r = .59–.88) as were the item-total correlations (r = .62–.91). For the "presenting a study" subscale, inter-item correlations were high (r = .54–.91) as were the item-total correlations (r = .74–.91).

DISCUSSION

Research provides the scientific foundation for clinical practice, yet less than 1% of nurses have a research doctorate (Institute of Medicine, 2011), and nurses begin research careers later in life (National Institute of Nursing Research, 2010). The shortage of a doctorally prepared workforce is not exclusive to the discipline of nursing and, in fact, extends to the basic biomedical sciences, behavioral and social sciences, and clinical sciences (NAS, 2011). The NAS report recommends several steps for addressing this shortage, including students' earlier entry and more rapid progression to doctoral and post-doctoral study. SCCT posits that college students with higher self-efficacy for research are more likely to select a career in research. Interventions to increase clinical research self-efficacy in undergraduate and first-year graduate students may increase the number of those selecting a research career, promoting earlier entry into research-focused doctoral programs. Therefore, a psychometrically sound scale that measures clinical research self-efficacy is needed to test the efficacy of interventions designed to increase undergraduate and first-year graduate students' confidence to perform tasks and activities necessary to conduct nursing research.

Although the 92-item CRAI is an appropriate scale for measuring clinical research self-efficacy in physician-scientists, the scale includes higher level clinical research skills not yet achieved by students earlier in their studies. In this study, we examined the factor structure and psychometric properties of the CRAI-SF, a modified version of the CRAI, in 268 undergraduate and first-year graduate students who were in a mentored research relationship.

Content validity of the 46-item CRAI-SF was supported by external review by a panel of experts. Construct validity of the scale was supported by the results of factor analysis, which revealed a 6-factor structure for the CRAI-SF that explained a high percentage of variance. Item factor loadings were strong as were item-to-factor correlations. Internal consistency was good for all 6 factors and for the total scale. It is noteworthy that after reducing the number of items by half, 6 of 10 factors of the original CRAI were observed in factor analysis of the CRAI-SF. This supports the notion that although higher level research skills (funding a study; planning and managing a study; collecting, recording, and analyzing data; interpreting data) are not relevant to students early in their academic studies, the scale does measure clinical research skills that can be acquired across all levels of study.

Construct validity of the scale was also supported by significant differences observed in CRAI-SF scores by respondents' gender and discipline of study. We observed significantly higher scores in males compared to females. This finding is consistent with Mullikin and colleagues (2007) who reported significantly higher CRAI scores in male versus female medical students, postdoctoral trainees, and MD or MD/PhD faculty.

Scores on the "protecting research subjects" factor of the CRAI-SF differed significantly by discipline of study, supporting the construct validity of the scale as a measure of clinical research self-efficacy. Higher scores were observed for respondents in nursing/health sciences compared to those in both the natural sciences and engineering/mathematics. This factor contains items relevant to clinical research with human subjects, thus it was anticipated that we would observe lower scores from respondents in the natural sciences and engineering/mathematics in which research entails laboratory research, product design and development, problem solution, and mathematical models rather than human subjects' research.

Although Mullikin et al. (2007) did report significant differences in clinical research self-efficacy by respondent rank (fellows and assistant professors to tenured faculty), we did not find significant differences in CRAI-SF scores between undergraduate and graduate students. This may be because more than 80% of our sample consisted of undergraduates. Also, in the Mullikin and colleagues' study, there were five career stages, ranging from medical students to full professors. The differences between undergraduate and first-year graduate students may not be large enough to be significant.

Convergent validity of the CRAI-SF was supported by significant correlations with the SES. Although items in the SES do not include indicators of clinical research self-efficacy, the scale does include general knowledge and skills common to all research endeavors. Significant positive correlations among all six factors of the CRAI-SF also supported convergent validity of the scale.

Results of this study demonstrated that the CRAI-SF is a concise, valid, and reliable measure sensitive to undergraduate and first-year master's students' perceived clinical research self-efficacy. Despite positive findings, limitations should be acknowledged. Although special attempts were made to recruit students from Historically Black Colleges and Universities (HBCUs), most of our sample consisted of Caucasian, non-Hispanic students. Thus, findings cannot be generalized to minority populations, and studies with ethnically and racially diverse students are needed. Although students were sampled from several universities, not all regions of the country were represented. Therefore, studies with a larger national sample, with equal numbers of undergraduate and graduate students and greater minority representation, are needed.

In nursing education, efforts to increase the number of students choosing research doctorates and, ultimately, research careers begin early in their educational trajectory. These include programs that introduce students to academic research, such as summer research internships, undergraduate scholars' and honors programs, and mentoring programs. The CRAI-SF can be used to evaluate the effects of interventions and research-focused programs on the clinical research self-efficacy of undergraduate and first-year graduate students.

The CRAI-SF, based on SCCT, can be used to test theoretical propositions regarding students' efficacy beliefs and career interests and choices. The scale can be used to assess the degree to which clinical-research self-efficacy is associated with undergraduate and first-year graduate students' interest in, and intent to pursue, a research career. In addition, longitudinal studies can be designed to assess the degree to which undergraduate and first-year graduate students' scores on the CRAI-SF predict progression to and completion of a PhD and, ultimately, a career as a nurse scientist.

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